*Economic Feasibility Technical Memo*

# Clinton Multimodal (U.S. 30 Mississippi River Bridge) Study

Prepared for

## Iowa Department of Transportation

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CTRE

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# 1.0 Introduction and Background

The purpose of this memorandum is to document the benefit-cost analysis of the river crossing concept alternatives described in the *Concept Alternatives Technical Memo.* Benefit-cost studies are designed to measure, in dollars, the potential positive or negative impacts of large-scale construction projects. The concept alternatives analyzed include improvements to the Union Pacific Railroad (UPRR) River Crossing and the U.S. Highway 30 (U.S. 30) River Crossing.

## 1.1 Overview of Concept Alternatives and Scenarios

Because of river navigation safety concerns associated with the existing UPRR River Crossing, the U.S. Coast Guard has issued an Order to Alter the swing span structure under the Truman-Hobbs Act. Therefore, the baseline used in the analysis to compare the UPRR River Crossing alternatives against is the low-level lift span alternative. This differs from the typical situation where a no-build alternative is used as a basis for comparison. The rail concept alternatives evaluated as part of the benefit-cost analysis are as follows:

- Low-Level Lift Span Railroad Bridge
- Mid-Level Lift Span Railroad Bridge
- High-Level Fixed Span Railroad Bridge (Examined as a separate structure and as a combined structure with the U.S. 30 Crossing)

Unlike the UPRR River Crossing, there is no legal obligation to alter or improve the existing U.S. 30 River Crossing. However, traffic forecasts for the river crossing show that it is expected to experience congestion by Year 2030 and be near or at capacity by 2050. The highway concept alternatives evaluated as part of the benefit-cost analysis are as follows:

- New Two-Lane Bridge to Complement Existing Two-Lane Bridge (Different design options were examined. Also examined as a separate structure and as a combined structure with the UPRR Crossing)
- New Four-Lane Bridge to Replace Existing Two-Lane Bridge (Different design options were examined. Also examined as a separate structure and as a combined structure with the UPRR Crossing)

The *Concept Alternatives Memo* describes the concept alternatives and their design variations in more detail. Using on the descriptions found in that memo, the highway and the rail alternatives were combined into a number of analysis scenarios. The scenarios are as follows:

- *Scenario 1*: Existing highway bridge and separate low-level lift span railroad bridge (baseline)
- *Scenario 2*: Complementary 2-lane suspension highway bridge and separate low-level lift span railroad bridge
- *Scenario 3*: 4-lane truss, tied-arch, or cable-stayed highway bridge and separate low level lift span railroad bridge

- *Scenario 4*: 4-lane suspension highway bridge and separate low level lift span railroad bridge
- *Scenario 5*: Complementary 2-lane suspension highway bridge and separate mid-level lift span railroad bridge
- *Scenario 6*: 4-lane truss, tied-arch, or cable-stayed highway bridge and separate mid-level lift span railroad bridge
- *Scenario 7*: 4-lane suspension highway bridge and separate mid-level lift span railroad bridge
- *Scenario 8*: Complementary 2-lane suspension highway bridge and separate high-level fixed span railroad bridge
- *Scenario 9*: 4-lane truss, tied-arch, or cable-stayed highway bridge and separate high-level fixed span railroad bridge
- *Scenario 10*: 4-lane suspension highway bridge and separate high-level fixed span railroad bridge
- *Scenario 11*: Combined deck truss 2-lane highway bridge and high-level fixed span railroad bridge (existing 2-lane bridge remains in place)
- *Scenario 12*: Combined thru truss 2-lane highway bridge and high-level fixed span railroad bridge (existing 2-lane bridge remains in place)
- *Scenario 13*: Combined 2-lane highway bridge and high-level fixed span railroad bridge with independent superstructures (existing 2-lane bridge remains in place)
- *Scenario 14*: Combined deck truss 4-lane highway bridge and high-level fixed span railroad bridge
- *Scenario 15*: Combined 4-lane highway bridge and high-level fixed span railroad bridge with independent superstructures

# 2.0 Benefit-Cost Analysis Background

In order to select a cost-effective bridge scenario, all relevant quantitative and qualitative impacts of each alternative should be considered. Qualitative costs are those that cannot be easily measured in dollars. They include environmental justice costs, environmental costs, economic development costs, and economic development benefits. Qualitative costs and benefits are detailed further in Section 3.0. For this study, quantitative costs include each alternative's construction, operating costs (when applicable), the cost of delay incurred by the Union Pacific Railroad for open bridge spans, the benefit of reducing barge allisions that occur with the current Union Pacific rail bridge, and the potential cost of driver delay as the U.S. 30 River Crossing nears capacity. Quantitative costs are used to calculate benefit-cost ratios and net benefits as part of a benefit-cost analysis. Quantitative costs and benefits are further detailed in Sections 4.0-7.0.

Cost-benefit analysis is performed for transportation improvement projects to better select an efficient transportation plan for affected communities and groups (*2*). A benefit-cost analysis compares a stream of present and future quantitative benefits from a project to a stream of present and future quantitative costs from the same project over a multi-year period. The Clinton multimodal bridge study focuses on the costs and benefits related to the construction of the UPRR Bridge, with possible U.S. Highway 30 Bridge construction later in the project timeline.

## 2.1 AASHTO Economic Analysis Methodology and Key Assumptions

The benefit-cost model used in this study is patterned after the eight-step economic analysis methodology used by the American Association of State and Highway Transportation Officials (AASHTO). The model steps are as follows:

1. Update user cost factors
2. Select economic study features
3. Describe project characteristics and estimate project construction costs
4. Calculate unit user costs
5. Calculate user benefits
6. Convert to annual benefits
7. Estimate residual value
8. Determine present values and economic desirability

--AASHTO, A Manual on User Benefit Analysis of Highway and Bus-Transit Improvements

The purpose of the benefit-cost analysis is to measure generated costs and benefits of each project alternative over the project's life cycle (*3*). The selection of economic study features and assumptions includes items such as the discount rate used to calculate present values, unit value of time, analysis period, and years of study for the benefit-cost model. The discount rate is used to calculate present values of project costs and benefits. The choice of discount rate is very important to the final model outcomes. The Office of Management and Budget recommends that a discount rate of 7% be used for public projects, with a sensitivity analysis using 5% and 9% discount rates (*4*). This project will follow the OMB guidelines for discount rates.

Costs and benefits for this benefit-cost analysis will be measured by year. This study assumes the construction completion date for an improved UPRR River Crossing to occur in 2010. Year 2010 was assumed as the date because of the standing Order to Alter issued by the U.S. Coast Guard in 1996. The construction completion date for an improved U.S. 30 River Crossing is assumed to occur in Year 2025. Year 2025 was assumed as the date because congestion is expected to begin around that time and because it makes the benefit period the same as for the UPRR Bridge. To test the sensitivity of this assumption, the scenarios were analyzed assuming that an improved U.S. 30 River Crossing was completed in 2030, when the crossing is forecast to operate at Level-of-Service (LOS) D/E. This LOS exceeds Iowa DOT level of congestion standards. The implementation dates of these transportation projects are key to the benefit-cost model.

This study assumes the useful life of any new railroad bridge alternative to be 90 years, and the useful life of any new highway bridge alternative to be 75 years. These assumptions are based on longevity of the current UPRR River Crossing and discussions with Iowa DOT staff. Using these useful life spans, the benefit period for the analysis will extend from the year 2010 (the railroad bridge completion date) to the year 2100 (the end of both bridges' useful lives).

In benefit-cost analysis, it is customary to calculate any residual or salvage value from existing conditions in the project area. This study, however, assumes no residual value from either the UPRR River Crossing or the U.S. 30 River Crossing. This is because, as stated in the *Concept Alternatives Technical Memo*, any salvage value is offset by the cost of removal.

The calculation of present values is needed to make net benefits from different years comparable. River crossing improvements, if constructed, will last for many years and the benefits and costs of each alternative need to be examined over each alternative's useful life. The present value of costs and benefits garnered through this project are calculated using the discount factors discussed previously- one benefit-cost model will use a 7% discount rate, and a sensitivity analysis will be performed using benefit-cost models with a 5% or 9% discount rate.

The differences in using the various discount rates are apparent in the final benefit-cost ratio. In order to understand the effect of different discount rates on the benefit-cost analysis results, **Figure 1** depicts the difference in value of a dollar over 90 years using different discount rates. As seen in this figure, the 5% discount rate allows for higher present values than the 7% or 9% discount rates, which translates to higher dollar amounts for most costs and benefits in the benefit-cost model.

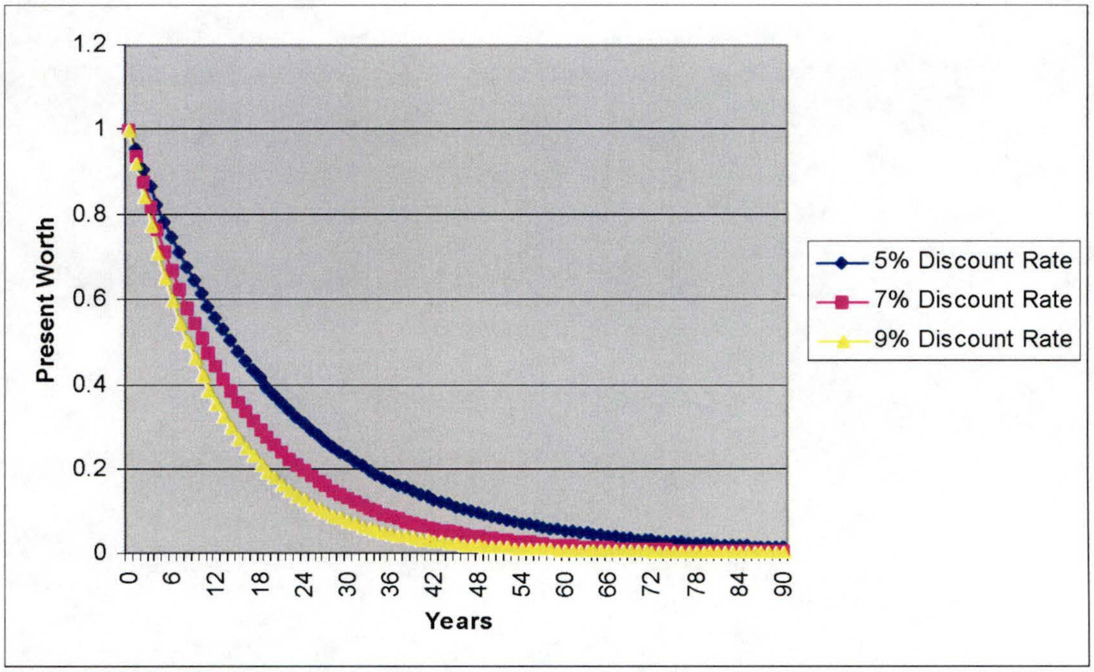


**Figure 1**. Impacts of Discount Rates on Present Value of $1 in 2010

# 3.0 Qualitative Costs and Benefits of Scenarios

As mentioned previously, some costs and benefits related to the analyzed river crossing improvements cannot be easily quantified. This section discusses these qualitative costs and benefits. The qualitative costs and benefits discussed include environmental justice costs, environmental costs, and economic development costs and benefits.

## 3.1 Environmental Justice

According to the *Socio-Economic Technical Memo*, certain bridge alternatives could potentially have negative environmental justice impacts in Clinton. The memo states that there are ten Census tracts in Iowa and Illinois identified in the project area. Out of these ten tracts, two tracts in Clinton represent a relatively large number of low-income and minority households. Transportation improvement projects that occur within these two Census tracts *could* disproportionately impact these low-income or minority populations. However, bridge alignment locations have not defined enough to determine if environmental justice impacts would occur. Therefore, costs related to environmental justice concerns cannot even be qualitatively estimated.

## 3.2 Environmental

At this time, there are no projected impacts to air quality in the project area due to rail, barge, or highway traffic. The current bridges, even with rail delays, are not an EPA non-attainment area (5), and meet current emissions standards. However, if rail or highway traffic increases greatly due to higher bridge capacity with the new alternatives, further study should be completed. There is also little to differentiate the alternatives in terms of their impact on the environment, including air quality, water quality, wildlife habitat, and endangered species. Therefore, these impacts are not considered in the benefit-cost analysis.

## 3.3 Economic Development

The river crossing concept alternatives offer a series of tradeoffs in terms of economic development impacts. They are:

- The more expensive bridge alternatives would create larger short-term, positive economic impacts in terms of construction spending and related employment and income effects in the Clinton area. This favors alternatives that involve high spans and combination structures.

- All high span alternatives would allow for better grade separation from roadways that access to the area in Clinton immediately south of the UPRR. This might open up this area for commercial or other redevelopment.

- Alternatives where the new span is located to the north of the existing U.S. 30 span in downtown Clinton raise the possibility of negative impacts on existing commercial development in downtown Clinton.

- Long-term economic development impacts of *any* of the bridge alternatives beyond those already quantified would not be large in magnitude unless they are accompanied the creation of a four-lane U.S. 30 between Cedar Rapids, Iowa and Interstate 88 (I-88) in Illinois. This is because the majority of traffic on U.S. 30 in the study area is, at present, local in nature. U.S. 30 currently is not a viable alternative route to I-80 because of the difference in mean travel speed between the two routes. However, it should be noted that, at the state level, the economic development would likely be minimal because most of the benefit to the Clinton Area would be a transfer of benefits that currently accrue along I-80.

# 4.0 Quantitative Costs and Benefits

As mentioned in Section 2.0, the benefits and costs that could be quantified for this analysis include: bridge construction and operating costs, rail and auto traffic delay costs/benefits, and barge safety costs/benefits. These quantitative costs and benefits were measured using AASHTO standards and data from the 2000 Highway Capacity Manual.

## 4.1 Construction and Operating Costs

**Table 1** summarizes construction costs for the concept alternatives. The construction costs are categorized by bridge type. The highway bridge only alternatives range from $52 million to $93 million, the railroad bridge only alternatives range from $36 million to $62 million, and the combined highway and railroad bridge alternatives range from $81 million to $115 million.

**Table 1**
**Clinton-Fulton Multimodal Study**
**Construction Costs of Highway, Rail, and Combined Bridge Alternatives**

| Bridge Alternative | Construction Costs |
|---|---|
| U.S. 30 River Crossing Only | |
| Complementary Two-Lane Bridge | $52,000,000 |
| Four-Lane Truss, Tied-Arch or Cable-Stayed Bridge | $60,000,000 |
| Four-Lane Suspension Bridge | $93,000,000 |
| UPRR River Crossing Only | |
| Low-Level Lift-Span Railroad Bridge | $36,000,000 |
| Mid-Level Lift-Span Railroad Bridge | $62,000,000 |
| High-Level Fixed Span Railroad Bridge | $58,000,000 |
| Combined U.S. 30/UPRR River Crossing | |
| Two-Lane Combined Bridge | $89,000,000 |
| Two-Lane Combined Bridge, independent superstructures | $81,000,000 |
| Four-Lane Combined Bridge | $115,000,000 |
| Four-Lane Combined Bridge, independent superstructures | $112,000,000 |

SOURCE: *Concept Alternatives Technical Memo.*

Operating costs for the alternatives differ greatly. All of the fixed span alternatives have an operating cost of zero. The moveable span alternatives are estimated to have an annual operating cost of $600,000 because staff are needed on-site to operate the moveable span. The moveable span (low and medium-level) alternatives have operating costs reflected in the benefit-cost analysis.

The benefit-cost analysis does not include projected maintenance costs for individual concept alternatives. This is because the level of design completed for this study is not detailed enough to provide maintenance costs. Maintenance costs cannot be developed until specific design types and more detailed alignments are chosen. This is not expected to occur unless the environmental review, or NEPA Process, is initiated for one or both of the river crossing improvements. By not estimating maintenance costs, the benefit-cost analysis will favor certain alternatives that could have higher maintenance costs. For instance, structures with larger deck square footage or more steel in trusses might be anticipated to have higher maintenance costs, as would structures with span lifts or swings.

## 4.2 Delay Costs and Benefits for the Union Pacific Railroad

Train delay costs and cost reductions (i.e. benefits) related to the UPRR river crossing were included in the benefit-cost analysis. The costs stem from the need to open the rail bridge to allow river traffic to pass. Determining the cost of delay to trains waiting to cross the bridge provides a cost difference between the moveable and fixed rail span alternatives.

The *Rail Operations Technical Memo*, documents a delay cost per hour figure provided by the UPRR. This cost of delay figure, which is $450 per hour, includes operating, fuel, freight delay, and other related costs. The UPRR has used this figure in the past to estimate delay costs for other improvement projects undergoing environmental, or NEPA, review. The UPRR believes this figure to be a conservatively low estimate of hourly delay costs.

As part of a 1991 study, the U.S. Coast Guard calculated train delay costs related to UPRR bridge openings in Clinton. The U.S. Coast Guard reported that approximately 7% of trains crossing the bridge were delayed due to bridge openings (*1*). In their study, the U.S. Coast Guard estimated hourly costs of delay per train to be $362 (*1*). This cost of delay figure is lower than the $450 per hour figure calculated by the Union Pacific Railroad (*6*). However, for this study, the Union Pacific cost of delay figure of $450 per hour of delay (2003 dollars) was used in the benefit-cost analysis.

It should be noted that the time to open any of the moveable spans was estimated to be the same. Investigation into the time differences associated with opening a low-level or mid-level lift span revealed minimal differences. This is also true concerning the differences between the time to open the existing swing span and a new lift span.

## 4.3 Safety Benefits due to Reduced Barge Allisions

The U.S. Coast Guard has issued an Order to Alter the current UPRR swing-span bridge because there is a history of barge allisions (collisions) related to a narrow horizontal clearance under the bridge. The costs of these allisions average $48,159 each year in terms of repairs to the bridge supports and the protective dolphins. All of the proposed rail bridge alternatives would alleviate this problem. Therefore the current yearly costs incurred by barge operators and the UPRR due to damages would be seen as a benefit in the benefit-cost model for all of the three railroad bridge alternatives. It is estimated the railroad will save $4,334,310 in repair costs over the benefit period if the current swing span was replaced by a lift or fixed span.

## 4.4 Delay Costs and Benefits for Users of U.S. 30

Unlike the UPRR Bridge, the U.S. 30 Bridge does not have a legal order for replacement. The need for replacement of the U.S. 30 Bridge will depend on future evaluations by the Iowa DOT. As mentioned earlier, however, it was assumed that U.S. 30 improvements would be completed by 2025 because of forecasts of future congestion. A sensitivity analysis was completed to see how the results would change if this assumption was changed to 2030.

In order to calculate the estimated delay costs and benefits associated with the U.S. 30 Bridge, future traffic congestion across the existing two-lane bridge had to be converted into congested travel times and contrasted against un-congested travel times across an expanded four-lane bridge. This was completed by using the 2000 Highway Capacity Manual (HCM) to estimate how LOS changes would result in travel speed changes across the U.S. 30 Bridge. The travel speeds were then converted into travel times by factoring in the distance traveled across the bridge.

Average Annual Daily Traffic (AADT) and LOS forecasts in the *Existing and Future Traffic Conditions and Deficiencies Technical Memo* were used to complete the calculation of delay costs. AADT and LOS across the U.S. 30 Bridge for years 2010, 2025, 2030, and 2050 were either taken directly from the memo or interpolated using the available data points. Using the LOS estimates and travel speed relationships found in Exhibit 15-2 of the 2000 HCM, it was estimated that noticeable differences in travel speed across U.S. 30 are expected to begin in Year 2030 if improvements if the bridge is not expanded to four lanes. As a four-lane facility, the U.S. 30 Bridge is not forecast to have travel congestion during the benefit period.

Time delay costs were converted to dollar costs using the value-of-time figure of $12.60 per person per hour. The figure was calculated from average wage figures for Clinton County (*8*). This same figure was applied to persons in passenger vehicles and in heavy commercial vehicles. The percent of heavy commercial vehicles using the U.S. 30 Bridge is less than 10%. This, plus the fact that the time length of the delay was not long enough to significantly affect the value of goods, was the reason for not differentiating between heavy commercial vehicles and passenger vehicles. Also, truck driver wages, while higher than the average wage for the study area, are not high enough to warrant significant differences in the benefit-cost calculations.

It should be noted that delay costs were calculated only for people crossing the bridge during the times of the day when congestion is expected to occur. Statewide and U.S. 30 hourly traffic counts were used to estimate the periods of the day when congestion is expected. Based on the hourly counts, it was determined that the peak traffic period currently ranges from 10:00 AM to 6:00 PM. Peak traffic volumes do *not* occur during the morning period. About 55% of the daily traffic occurs during the peak traffic period. In 2030, it was assumed that 55% of the daily traffic experiences congestion. By 2050, when the LOS across the bridge is expected to be at F, it was assumed that the peak traffic period would spread out to include the morning period. This larger congestion period is estimated to include 75% of the daily traffic. The remaining 25% of the traffic occurs during the late evening and overnight period. In 2050 and beyond, it was assumed that 75% of the traffic would experience congestion (*9*).

# 5.0 Benefit-Cost Calculations and Results

Using the AASHTO process outlined previously, a set of matrices was developed to monetarily measure costs and benefits for each highway or rail bridge alternative separately. These separate costs and benefits were then combined into the 15 scenarios described in Section 1.1.

The assumptions used in calculating costs and benefits are summarized as follows:

- Free-flow speed of 45 (the posted speed limit) across the U.S. 30 Bridge in 2010
- The U.S. 30 Bridge Alternatives were classified as Urban Street II as seen in the 2000 HCM
- AADT growth rate of 1% per year based on forecasted traffic trends
- Travel speeds between 2050 and 2100 would not change unless the U.S. 30 Bridge is widened to four lanes.
- 1.2 persons per private automobile of working age (from Iowa metropolitan planning data)
- 1 person per single unit or semi-truck of working age
- The north option of four-lane bridge alternative was used for the distance calculations
- 7% single unit and semi-truck traffic based on Iowa DOT traffic counts
- Inflation is controlled through discounting in benefit-cost model
- Two-lane roads have average travel speeds at the bottom of the given speed ranges and four-lane roads have average travel speeds at the top of the given speed ranges found in Exhibit 15-2 of the 2000 HCM
- No delay due to congestion on any four-lane bridge alternatives once they are in service
- Hours of delay on two-lane bridges are the peak travel hours of: 2010-2030 (no congestion), 2030-2050 (10AM – 6 PM), 2050 (6 AM – 6 PM). Time periods are based on Iowa DOT hourly traffic counts

**Table 2** shows the benefit-cost ratio and the net benefits for the individual rail alternatives and the rail portion of the combined alternatives assuming a 7% discount rate. For reference, the benefit-cost ratios and net benefits calculated for the rail alternatives as part of a sensitivity analysis assuming a 5% and a 9% discount rate are located in **Appendix A**. **Table 2** shows that the mid-level and high-level rail crossing alternatives have benefits equal or greater than the costs incurred over the benefit period.

The scenarios that include mid-level and high-level rail spans have benefit-cost ratios at or greater than one because the cost savings associated with reducing rail delay are high under these alternatives. Although barge safety cost savings occur under the low rail span alternative scenarios, these cost savings, or benefits, do not exceed the cost associated with low-span construction, which results in a benefit-cost ratio of below one.

**Table 3** shows the benefit-cost ratio and the net benefits for the individual highway alternatives and the highway portion of the combined bridge alternatives assuming a 7% discount rate. For comparative purposes, this information was shown for two different construction completion dates, 2025 and 2030. **Appendix A** contains the corresponding analysis results assuming a discount rate of 5% and 9%, respectively. **Table 3** shows that the complementary two-lane suspension bridge and the four-lane truss bridge accrue benefits that are roughly equal to their costs during the benefit period. The *highway portion* of the two-lane combined bridge alternatives all have benefits that are less than the costs accrued during the benefit period. This is also true for the *highway portion* of the four-lane combined bridge alternatives and the four-lane suspension bridge alternative.

**Table 4** shows the benefit-cost ratios and the net benefits for the 15 scenarios described in Section 1.1. The scenarios depict the sum of costs and benefits for the different combinations of rail and highway alternatives. For reference, **Appendix A** contains the corresponding analysis results assuming a discount rate of 5% and 9%. The table shows that all but the low-level lift span alternative scenarios are expected to have benefits that are greater than the costs accrued over the benefit period. It should be noted that for the scenarios where the rail and highway bridges share the same substructure, the benefit-cost ratio is greater than one *only* because the benefits for the railroad are so great. When the highway costs and benefits for the shared bridge alternatives are examined separately (as in **Table 3**), it can be seen that the highway benefits for the shared alternatives are less than the highway costs.

**Table 2**
**Clinton-Fulton Multimodal Study**
**Summary – Rail Bridge Alternatives Benefit-Cost Ratios and Net Benefits**

| Rail Alternatives | 2010 Bld B/C Ratio (7% Discount) | Net Benefits |
|---|---|---|
| Low-Level Lift-Span Railroad Bridge | NA* | NA* |
| Mid-Level Lift-Span Railroad Bridge | 1.1 | $3,235,154 |
| High-Level Fixed-Span Railroad Bridge | 1.7 | $38,361,620 |
| Rail-Only Portion of Combined Bridge | 1.9 | $37,048,671 |

* Baseline alternative used to calculate costs and benefits of other alternatives.

**Table 3**
**Clinton-Fulton Multimodal Study**
**Summary – Highway Bridge Alternatives Benefit-Cost Ratios and Net Benefits**

| Highway Alternatives | 2025 Bld B/C Ratio (7% Discount) | Net Benefits | 2030 Bld B/C Ratio (7% Discount) | Net Benefits |
|---|---|---|---|---|
| Complimentary Two Lane Highway Bridge | 1.1 | $2,764,555 | 1.6 | $7,581,150 |
| Four Lane Truss Highway Bridge | 1.0 | -$135,013 | 1.4 | $5,513,798 |
| Four Lane Suspension Highway Bridge | 0.6 | -$12,095,732 | 0.9 | -$3,014,029 |
| Two Lane Combined Highway/Rail Bridge (Deck-Truss) | 0.7 | -$9,558,610 | 0.9 | -$1,205,096 |
| Two Lane Combined Highway/Rail Bridge (Thru-Truss) | 0.7 | -$10,645,948 | 0.9 | -$1,980,353 |
| Two Lane Combined Highway/Rail Bridge (Superstructure) | 0.7 | -$7,746,379 | 1.0 | $86,999 |
| Four Lane Combined Highway/Rail Bridge (Deck-Truss) | 0.5 | -$20,069,544 | 0.7 | -$8,699,247 |
| Four Lane Combined Highway/Rail Bridge (Superstructure) | 0.5 | -$18,982,206 | 0.7 | -$7,923,990 |

**Table 4**
**Clinton-Fulton Multimodal Study**
**Summary – Bridge Scenarios Benefit-Cost Ratios and Net Benefits**

| Highway and Rail Bridge Scenario | 2010/2025 Bld B/C Ratio (7% Discount) | Net Benefits | 2010/2030 Bld B/C Ratio (7% Discount) | Net Benefits |
|---|---|---|---|---|
| 1: Existing Hwy and new low-level RR lift span | NA* | NA* | NA* | NA* |
| 2: Complimentary 2-Ln Hwy and Low-level RR Lift Span | 0.4 | -$32,429,019 | 0.4 | -$27,612,423 |
| 3: 4-Ln truss hwy and low-level RR lift span | 0.4 | -$35,328,587 | 0.4 | -$29,679,776 |
| 4: 4-Ln suspension hwy and low-level RR lift span | 0.3 | -$47,289,306 | 0.4 | -$38,207,603 |
| 5: Complimentary 2-Ln hwy and mid-level RR lift span | 1.1 | $5,999,709 | 1.1 | $10,816,305 |
| 6: 4-Ln truss hwy and mid-level RR lift span | 1.0 | $3,100,141 | 1.1 | $8,748,953 |
| 7: 4-Ln suspension hwy and mid-level RR lift span | 0.9 | -$8,860,577 | 1.0 | $221,126 |
| 8: Complimentary 2-Ln hwy and high-level RR fixed span | 1.5 | $41,126,175 | 1.6 | $45,942,771 |
| 9: 4-Ln truss hwy and high-level RR fixed span | 1.5 | $38,226,607 | 1.6 | $43,875,419 |
| 10: 4-Ln suspension hwy and high-level RR fixed span | 1.3 | $26,265,889 | 1.4 | $35,347,592 |
| 11: Combo 2-Ln hwy and high-level RR fixed span (deck truss) | 1.8 | $25,007,963 | 2.0 | $23,377,842 |
| 12: Combo 2-ln hwy and high-level RR fixed span (thru truss) | 1.7 | $23,892,354 | 2.0 | $22,582,428 |
| 13: Combo 2-Ln hwy and high-level RR fixed span (superstructure) | 1.7 | $48,274,131 | 1.8 | $52,451,272 |
| 14: Combo 4-Ln hwy and high-level RR fixed span (deck truss) | 1.3 | $14,418,015 | 1.5 | $15,827,355 |
| 15: Combo 4-Ln hwy and high-level RR fixed span (superstructure) | 1.6 | $42,026,434 | 1.7 | $47,366,182 |

* This is the baseline alternative used to calculate costs and benefits of other alternatives.

# 6.0 Conclusions

The benefit-cost analysis presented measures potential positive or negative impacts of suggested highway, railroad, and combined highway and railroad bridge crossing alternatives over the Mississippi River. The benefit-cost analysis quantified train delays (and corresponding delay reductions) associated with the UPRR alternatives, future highway delay costs (and corresponding cost savings) related to the U.S. 30 alternatives, and safety cost savings associated with the swing span pier removal. Benefit-cost calculations for the rail alternatives (**Table 2**) revealed the following:

- The low and mid-level lift span bridge alternatives did not perform nearly as well as the high-level fixed-span rail bridge alternative.

Benefit-cost calculations for the highway alternatives (**Table 3**) revealed the following:

- The complimentary two-lane bridge and the four-lane truss bridge alternatives performed the best; however, both alternatives had higher benefit-cost ratios in the year 2030 rather than 2025.

After calculating benefits and costs for the UPRR and U.S. 30 alternatives separately, the alternatives were combined to create improvement scenarios the UPRR and U.S. 30. Benefit-cost ratios were then calculated for each combination scenario. Based on the analysis results shown in **Table 4**, the alternative scenarios with the calculated benefits greatly exceeding the calculated costs are as follows (in descending order of ratio):

- 11: Combined two-lane highway bridge and high-level fixed span railroad bridge (deck truss)
- 12: Combined two-lane highway bridge and high-level fixed span railroad bridge (thru truss)
- 13: Combined two-lane highway bridge and high-level fixed span railroad bridge (superstructure)
- 15: Combined four-lane highway and railroad bridge (superstructure)
- 8: Complementary two-lane highway bridge and separate high-level fixed span railroad bridge
- 9: Four-lane truss highway bridge and separate high-level fixed span railroad bridge
- 10: Four-lane suspension highway bridge and separate high-level fixed span railroad bridge
- 14: Combined four-lane highway and railroad bridge (deck truss)

The alternative scenarios with the calculated benefits roughly equivalent to the calculated costs are as follows (in descending order of ratio):

- 5: Complementary two-lane highway bridge and separate mid-level lift span railroad bridge
- 6: Four-lane truss highway bridge and separate mid-level lift span railroad bridge
- 7: Four-lane suspension highway bridge and separate mid-level lift span railroad bridge

The alternative scenarios with the lowest benefits relative to costs are as follows:

- 4: Four-lane suspension highway bridge and low-level railroad lift span bridge
- 2: Complementary two-lane highway and low-level railroad lift span bridge
- 3: Four-lane truss highway bridge and low-level lift span railroad bridge

The scenario results show that the scenarios with the best benefit-cost ratio all include the high-level fixed span rail bridge. It should be noted that, even though the shared bridge alternatives performed similarly or better than the separate independent bridge alternatives, the benefits under the shared bridge alternatives are not as great for U.S. 30. The U.S. 30 bridge approaches for the shared bridge options are longer than when individual bridge substructures are built. The longer approaches increase costs for U.S. 30. These cost increases are offset by construction cost savings for the UPRR. This can be seen in **Table 2**; the benefit-cost ratio of constructing only the rail portion of the combined highway and rail bridge is very high (1.9), and the overall benefit-cost ratios for the complete bridge are slightly lower. For a combination alternative to be feasible, the Iowa and Illinois DOT's would have to work with the UPRR to determine how construction cost savings should be allocated.

# 7.0 Recommended Next Steps

This study is a coarse-level analysis of concept alternatives; because of this, further analysis of a selected bridge scenario should be completed at a later date. Any construction project would likely not begin until at least the year 2010, and the factors measured in this benefit-cost analysis are dynamic and are subject to change before that time. A more in-depth study closer to a chosen project's beginning would not only have access to data more timely to the project, but would be able to better forecast and analyze potential impacts to the environmental, economic development, environmental justice, highway traffic, rail traffic, and barge traffic. If the development of a rail or highway river crossing project is pursued, the concept alternatives should be refined so that maintenance costs can be developed. The economic analyses should then be revised to include maintenance costs as it may change which alternative looks the most feasible from an economic perspective.

# 8.0 References

1 – U.S. Department of Transportation and U.S. Coast Guard. Detailed Report on the Obstructive Character of the Clinton Railroad Bridge Mile 518.0, Upper Mississippi River, Clinton Iowa. St. Louis, MO: Second Coast Guard District. September 1995

2- AASHTO, A Manual on User Benefit Analysis of Highway and Bus-Transit Improvements, 1977

3- Economic Analysis Primer. U.S. Department of Transportation, Federal Highway Administration, August 2003

4- Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. Office of Management and Budget, Executive Office of the President of the United States of America, 1992.

5- EPA AirData Monitor Values Report for Clinton, Iowa. www.oaspub.epa.gov/airdata. Accessed June 26, 2003

6 – Union Pacific Railroad

7 –2000 Highway Capacity Manual. Transportation Research Board, National Research Council, Washington, D.C., 2000.

8 – Covered Employment and Wages, Iowa Workforce Development, Employment Statistics Bureau, 2002

9 – U.S. 30 Highway bridge traffic counts, Iowa DOT, 2003

# Appendix A:
# Sensitivity Analysis of Benefit-Cost Results

**Table A-1**
**Clinton-Fulton Multimodal Study**
**Discount Rate Sensitivity Analysis, 5% and 9% Discount Rates– Rail Bridge**

| Rail Alternatives | 2010 Bld B/C Ratio (5% Discount) | Net Benefits | 2010 Bld B/C Ratio (9% Discount) | Net Benefits |
|---|---|---|---|---|
| Existing hwy bridge and low level RR lift-span | NA* | NA* | NA* | NA* |
| Existing hwy bridge and mid level RR lift-span | 1.5 | $28,505,499 | 0.8 | -$11,226,763 |
| Existing hwy bridge and high level RR fixed-span | 2.3 | $75,365,480 | 1.3 | $17,184,753 |

* Baseline alternative used to calculate costs and benefits of other alternatives.

**Table A-2**
**Clinton-Fulton Multimodal Study**
**Discount Rate Sensitivity Analysis, 5% Discount Rate – Highway Bridge**

| Highway Alternatives | 2025 Bld B/C Ratio (5% Discount) | Net Benefits | 2030 Bld B/C Ratio (5% Discount) | Net Benefits |
|---|---|---|---|---|
| Complimentary Two Lane Highway Bridge | 2.2 | $30,387,760 | 2.8 | $34,937,817 |
| Four Lane Truss Highway Bridge | 1.9 | $26,539,623 | 2.4 | $31,922,701 |
| Four Lane Suspension Highway Bridge | 1.2 | $10,666,059 | 1.6 | $19,485,348 |
| Two Lane Combined Highway/Rail Bridge (Deck-Truss) | 1.3 | $14,033,178 | 1.7 | $22,123,574 |
| Two Lane Combined Highway/Rail Bridge (Thru-Truss) | 1.3 | $12,590,127 | 1.6 | $20,992,906 |
| Two Lane Combined Highway/Rail Bridge (Superstructure) | 1.4 | $16,438,264 | 1.8 | $24,008,022 |
| Four Lane Combined Highway/Rail Bridge (Thru-Truss) | 1.0 | $83,683 | 1.3 | $11,193,779 |
| Four Lane Combined Highway/Rail Bridge (Superstructure) | 1.0 | $1,526,734 | 1.3 | $12,324,448 |

**Table A-3**
**Clinton-Fulton Multimodal Study**
**Discount Rate Sensitivity Analysis, 9% Discount Rate – Highway Bridge**

| Highway Alternatives | 2025 Bld B/C Ratio (9% Discount) | Net Benefits | 2030 Bld B/C Ratio (9% Discount) | Net Benefits |
|---|---|---|---|---|
| Complimentary Two Lane Highway Bridge | 0.7 | -$4,519,859 | 1.0 | $68,395 |
| Four Lane Truss Highway Bridge | 0.6 | -$6,716,163 | 0.9 | -$1,359,052 |
| Four Lane Suspension Highway Bridge | 0.4 | -$15,775,919 | 0.6 | -$7,247,271 |
| Two Lane Combined Highway/Rail Bridge (Deck-Truss) | 0.4 | -$13,854,152 | 0.6 | -$5,998,255 |
| Two-Lane Combined Highway/Rail Bridge (Thru-Truss) | 0.4 | -$14,677,766 | 0.6 | -$6,533,548 |
| Two Lane Combined Highway/Rail Bridge (Superstructure) | 0.4 | -$12,481,462 | 0.6 | -$5,106,101 |
| Four Lane Combined Highway/Rail Bridge (Deck-Truss) | 0.3 | -$21,815,756 | 0.5 | -$11,172,751 |
| Four Lane Combined Highway/Rail Bridge (Superstructure) | 0.3 | -$20,992,141 | 0.5 | -$10,637,458 |

**Table A-4**
**Clinton-Fulton Multimodal Study**
**Discount Rate Sensitivity Analysis, 5% Discount Rate – Bridge Scenarios**

| Highway and Rail Bridge Scenario | 2010/2025 Bld B/C Ratio (5% Discount) | Net Benefits | 2010/2030 Bld B/C Ratio (5% Discount) | Net Benefits |
|---|---|---|---|---|
| 1: Existing Hwy and new low-level RR lift span | NA* | NA* | NA* | NA* |
| 2: Complimentary 2-Ln Hwy and Low-level RR Lift Span | 0.9 | -$4,540,991 | 1.0 | $9,066 |
| 3: 4-Ln truss hwy and low-level RR lift span | 0.9 | -$8,389,128 | 0.9 | -$3,006,050 |
| 4: 4-Ln suspension hwy and low-level RR lift span | 0.7 | -$24,262,692 | 0.8 | -$15,443,403 |
| 5: Complimentary 2-Ln hwy and mid-level RR lift span | 1.7 | $58,893,259 | 1.8 | $63,443,316 |
| 6: 4-Ln truss hwy and mid-level RR lift span | 1.6 | $55,045,122 | 1.7 | $60,428,200 |
| 7: 4-Ln suspension hwy and mid-level RR lift span | 1.4 | $39,171,558 | 1.5 | $47,990,847 |
| 8: Complimentary 2-Ln hwy and high-level RR fixed span | 2.3 | $105,753,240 | 2.4 | $110,303,297 |
| 9: 4-Ln truss hwy and high-level RR fixed span | 2.2 | $101,905,103 | 2.3 | $107,288,181 |
| 10: 4-Ln suspension hwy and high-level RR fixed span | 1.8 | $86,031,539 | 2.0 | $94,850,828 |
| 11: Combo 2-Ln hwy and high-level RR fixed span (deck truss) | 2.9 | $77,026,600 | 3.2 | $71,119,685 |
| 12: Combo 2-ln hwy and high-level RR fixed span (thru truss) | 2.8 | $75,546,029 | 3.1 | $69,959,619 |
| 13: Combo 2-Ln hwy and high-level RR fixed span (superstructure) | 2.5 | $113,630,052 | 2.7 | $117,540,037 |
| 14: Combo 4-Ln hwy and high-level RR fixed span (deck truss) | 2.1 | $62,972,242 | 2.4 | $60,107,728 |
| 15: Combo 4-Ln hwy and high-level RR fixed span (superstructure) | 2.3 | $106,057,205 | 2.5 | $111,130,920 |

* This is the baseline alternative used to calculate costs and benefits of other alternatives.

**Table A-5**
**Clinton-Fulton Multimodal Study**
**Discount Rate Sensitivity Analysis, Discount Rate 9% – Bridge Scenarios**

| Highway and Rail Bridge Scenario | 2010/2025 Bld B/C Ratio (9% Discount) | Net Benefits | 2010/2030 Bld B/C Ratio (9% Discount) | Net Benefits |
|---|---|---|---|---|
| 1: Existing Hwy and new low-level RR lift span | NA* | NA* | NA* | NA* |
| 2: Complimentary 2-Ln Hwy and Low-level RR Lift Span | 0.2 | -$39,864,988 | 0.2 | -$35,276,734 |
| 3: 4-Ln truss hwy and low-level RR lift span | 0.2 | -$42,061,292 | 0.2 | -$36,704,181 |
| 4: 4-Ln suspension hwy and low-level RR lift span | 0.2 | -$51,121,048 | 0.2 | -$42,592,401 |
| 5: Complimentary 2-Ln hwy and mid-level RR lift span | 0.8 | -$15,746,622 | 0.8 | -$11,158,368 |
| 6: 4-Ln truss hwy and mid-level RR lift span | 0.8 | -$17,942,926 | 0.8 | -$12,585,815 |
| 7: 4-Ln suspension hwy and mid-level RR lift span | 0.7 | -$27,002,681 | 0.8 | -$18,474,034 |
| 8: Complimentary 2-Ln hwy and high-level RR fixed span | 1.2 | $12,664,894 | 1.3 | $17,253,148 |
| 9: 4-Ln truss hwy and high-level RR fixed span | 1.1 | $10,468,589 | 1.2 | $15,825,701 |
| 10: 4-Ln suspension hwy and high-level RR fixed span | 1.0 | $1,408,834 | 1.1 | $9,937,481 |
| 11: Combo 2-Ln hwy and high-level RR fixed span (deck truss) | 1.3 | $6,596,778 | 1.5 | $7,282,239 |
| 12: Combo 2-ln hwy and high-level RR fixed span (thru truss) | 1.3 | $19,272,479 | 1.4 | $23,269,962 |
| 13: Combo 2-Ln hwy and high-level RR fixed span (superstructure) | 1.2 | $5,751,750 | 1.4 | $6,733,029 |
| 14: Combo 4-Ln hwy and high-level RR fixed span (deck truss) | 1.0 | -$1,424,674 | 1.1 | $2,068,846 |
| 15: Combo 4-Ln hwy and high-level RR fixed span (superstructure) | 1.2 | $14,007,242 | 1.3 | $19,078,819 |

* This is the baseline alternative used to calculate costs and benefits of other alternatives.